



How to set up a vibratory bowl for gear finishing

Open or tight roll patterns, bowl motions, rolling speed, and alignment angles are among possible adjustments to get optimal mass motion.

This is the first in a multi-part series on vibratory processing of gears. This article is focused on machine set-up for optimal mass motion.

OVERVIEW OF THE VIBRATORY BOWL

The vibratory bowl is toroidal-shaped, consisting of a center hub surrounded by an OD wall. Direct drive machines have a motor and driveshaft set inside the center hub. Indirect drive machines have an externally mounted motor and V-belts to turn the driveshaft inside the center hub. When operating, the bowl moves up and down on springs peripherally mounted to its base. The motion, combined with the rotational inertia of the motor, generates two planes of mass motion: vertical roll and horizontal slide. Combined, the two generate a helical mass pathway.

SETTING UP THE VIBE BOWL FOR OPTIMUM GEAR-FINISHING PERFORMANCE

Amplitude is a commonly cited tool for gauging the correct machine action and it is a measure of the expansion and compression on the bowl's springs. It is measured with an amplitude sticker mounted to the side of the O.D. wall. A higher amplitude means the springs have greater expansion and compression.

Place a part in the vibe bowl and, using a stopwatch, note the motion path and time in seconds required for it to make one lap around the bowl channel. For example, if a part rolls eight times per minute as it completes one lap around the channel, it will have traveled a further distance compared to a part that rolled just four times per one lap in the same minute of time. In the former scenario, the machine is said to have a tighter roll pattern as opposed to the latter scenario, in which the machine has a more open roll pattern.

The farther the distance the part travels to complete one lap, the more media contact the part receives, and the more refinement work that is being done. Optimally, it is desirable to maximize part rolls per lap within the physical constraints afforded by the part's volumetric dimensions.

KNOWING THE DIFFERENCE OF CHOICE BETWEEN AN OPEN OR TIGHT ROLL PATTERN

Let's use as an example two gear processing scenarios, both gears heat-treated and ground. In the first, the goal is to process a three-inch diameter spur gear with a flank length of one inch. In the second, the part is a three-inch diameter by 18-inch long sun shaft. In these examples, we are not interested in DP and tooth count, just the generic morphological part forms and the volumetric displacement of each part.

Since the bowl's center hub has a smaller diameter than its OD wall, the helical spiral of motion will be tightest at the center hub. Consequently, parts are closer to one another as they plunge downward at the center hub. Each section of bowl channel, as determined visually by one part roll, is pie-wedged in shape, tighter adjacent to the center hub.

Since the three-inch diameter spur gear is more compact than the elongated sun shaft, it is more favorably finished using the tighter, eight rolls per minute lap pattern. If run with the same roll pattern, the elongated sun shaft will knot with its channel partners, like a child's pick-up sticks, since there is a tighter pie-wedge pattern at the center hub. This greatly increases the propensity for part-on-part damage. Inversely, the elongated sun shaft would be favored to run with a more open, fewer rolls per minute lap pattern. Perhaps just one or two rolls per lap.



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HOW TO ADJUST BOWL MOTION PATTERNS AND ROLLING SPEED

As mentioned previously, the bowl's driveshaft has weight segments mounted to its top and bottom. This is common to all vibe bowls. Different manufacturers have different styles, shapes, and sizes of weights, but rest assured, all machines have them. By adding weights to the bottom of the shaft, you increase bowl amplitude. Removing weights from the bottom does the opposite, decreasing bowl amplitude. Adding weights to the top yields a more open spiral pattern, favoring the 18-inch long sun shaft. Removing weights from the top generates a tighter spiral pattern, favoring the three-

inch diameter spur gear.

Alternatively, the alignment angles between the top and bottom of the driveshaft are critical to controlling the mass rolling speed. These normal settings and steps should always be followed:

When starting the machine, be certain the motor is rotating in the correct direction. Compare motor rotation with the directional arrow decal on the bottom hatch cover. If the motor is rotating in the wrong direction, reverse the hot and neutral leads to the motor to change polarity and reverse motor rotation.

Assuring correct motor rotation, the media mass must move in the opposite direction. Sir Isaac Newton taught us all that every action has an equal and opposite reaction. As the motor rotates correctly, its media naturally moves in the opposite direction. If both the media and the motor are rotating in the same direction, then the motor is reversed. Change motor polarity as described earlier.

Make certain that the bottom weights lead the top weights into the motor rotation direction.

Always set up the machine with the bottom weight leading the top weight at a 90° angle.

CHANGING TOP TO BOTTOM WEIGHT ALIGNMENT ANGLES

Should you decide to change alignment angles from the typical 90° alignment angle, most bowls are equipped with a thumbscrew and 360° gauge at the bottom of the drive shaft. Loosen the set pin, then turn the thumbscrew to generate a more acute or more obtuse angle. Then tighten the set pin.

A more acute angle concentrates the top and bottom weight segments to one side of the drive shaft, making it more imbalanced. This speeds up rolling speed. A more obtuse angle balances out the weight segments on the drive shaft, producing a slower rolling speed. A slower rolling speed means the part will move forward a farther distance between rolls, thereby automatically creating a more open spiral pattern. 

ABOUT THE AUTHOR

William (Bill) P. Nebiolo received a B.A. from The University of Connecticut and an M.S. in environmental sciences from Long Island University. He has been with REM Surface Engineering since 1989 and currently serves as a sales engineer and as REM's product manager. Since 1978, Nebiolo has been an active member in the National Association for Surface Finishing (NASF) where he has represented the Connecticut chapter as an NASF national delegate and is the 2010, 2014, and 2015 recipient of the NASF National Award of Merit. From 1996 to 2000, he served as one of SME's Mass Finishing technical training program instructors. He has published and presented dozens of technical papers and is the author of the SME Mass Finishing Training Book. Nebiolo can be reached at bnebiolo@remchem.com.



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